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INTENSE LOW-FREQUENCY SOUNDS FROM
AN ANTARCTIC MINKE WHALE,
BALAENOPTERA ACUTOROSTRATA

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ABSTRACT. Intense low-frequency underwater sounds, somewhat similar to those heard from other species of *Balaenoptera*, have been recorded from minke whales, *Balaenoptera acutorostrata* Lacépède 1804, in the Ross Sea, Antarctica.

The small *Balaenoptera* (minke whales) of the Antarctic had for many years been identified as *B. acutorostrata* Lacépède 1804, until Williamson (1959 and 1961) indicated that some of them might be referable to *B. bonaerensis* Burmeister 1867, which van Utrecht and van der Spoel (1962) considered no more than a variety. Since our Ross Sea whales showed us only the top of the back and the part of the head from the blowholes forward (Fig. 1), we could not judge whether they were this form or the typical *acutorostrata*, so we refrained from reporting the sounds till the relationship of these Antarctic minke whales to those in other parts of the world was more clearly defined. Ohsumi, Masaki, and Kawamura (1970) have now compared the southern and northern forms and concluded (p. 116) that any differences were minor and that the Antarctic minke whale was not taxonomically separable from the typical northern *Balaenoptera acutorostrata*, and this conclusion we happily accept.

Our recordings were made from the edge of the Ross ice shelf 2 km east of Cape Crozier, Ross Island, on 22 November 1964. A whale had been sighted earlier in the 4-km stretch of open water between the ice shelf and the loose pack-ice further out, but it was too far away for identification. A light northerly wind eventually closed this open water and drove the pack-ice against the ice shelf. Large chunks of ice were forced on edge,

and the loose ice was pushed together against the shelf, forming a solid cover as far as the eye could see.

We had been listening underwater for ice sounds as the pack came in and had forgotten about the whale sighting, when we were startled by the characteristic sound of a whale blow in air. A minke whale had thrust its head out through a hole in the ice far enough to breathe (Fig. 1). In an 8-m whale, this means nearly 1.5 m. There were three holes nearby, apparently kept open by emperor penguins, *Aptenodytes forsteri* G. R. Gray 1844, in relatively thin ice that had formed behind a projecting tongue of the ice shelf. We were using the nearest for our hydrophone, and the whales appeared in one about 5 m further away.

The whale sounds had been noted, but not identified, in the underwater ambient before the whales' appearance. There were two minke whales, though at first we saw only one at a time. Later both were visible at once as they blew in adjacent holes. The whales came from the direction of the ice pack and would return again in that direction after a series of blows. Five to ten minutes elapsed between series of four to seven blows.

Examination of the recordings reveals that initially there were two whales producing sounds, one relatively close by and a second at a distance. Sounds produced when the whale was close by often took us by surprise and massively overloaded the sound equipment. The loud sounds were heard when a whale was near the breathing holes, and therefore near the hydrophone, either just before or just after a series of blows. The blows were barely audible underwater.

The background ambient on the day of these recordings was filled with a wide variety and range of sounds. Though most of these remain unidentified, occasionally some could be matched to ice movement and also to a single visit from a leopard seal, *Hydrurga leptonyx* (Blainville 1820). Others were recognized as sounds from Weddell seals, *Leptonychotes weddelli* (Lesson 1826). We had been working for some weeks in McMurdo Sound in an acoustically pure culture of *Leptonychotes* and we were confident that we could recognize most of their vocalizations. Throughout this entire day's listening, these seals were heard quite often as they moved from crack to crack under the more solid ice cover. They were audible except during the period of the approach of the minke whales. During this time, a period of about 30 minutes, the Weddell seals were silent.

EQUIPMENT AND METHODS

The sounds were recorded with an LC-34 (Atlantic Research) hydrophone and a WHOI-built amplifier and spring-driven recorder (Watkins, 1963). Analysis playback was on Crown (800 series) recorders. The combined frequency response was flat within $\frac{1}{2}$ dB from 30 to 30,000 Hz. Spectograms were made on a Kay Electric 7029A Sound Spectograph.

The hydrophone was thrown from the ice shelf across thin ice through holes used by emperor penguins, *Aptenodytes forsteri*. The hydrophone was suspended 3 meters or more in the water from the ice edge, but since the cable was operating at low impedance, no noise was generated by motion of the cable against the ice.

CHARACTERISTICS OF THE WHALE SOUNDS

The minke whale sounds were intense. The loudest of these in undistorted recording are 60 to 65 dB above the local relatively high background ambient, which averaged about 0 dB re 1 dyne/cm². Of course, we do not know how near the whales were, but we assume they were quite near, since the loudest sounds occurred either a few seconds before or after a whale was seen in a breathing hole. Thus, 65 dB re 1 dyne/cm² may be nearly the maximum (1 m) signal strength of these whale sounds.

The sounds were composed of a single downward sweep in frequency, starting at 130 to 115 Hz and sweeping to about 60 Hz (see Fig. 2). Since the frequency sweep continued throughout the sound, the rate of drop in frequency varied with both the span of frequencies and the duration of the call. The sweep rate was fairly regular throughout each sound.

Sounds that were recorded at a low enough level to be free from distortion had no harmonic structure; they appear to have been composed of nearly sinusoidal waves. The second and third traces visible with each sound in Figure 2 are from reflections off ice walls or the bottom.

The minke whale sounds began with gradually increasing intensity for the first few cycles and ended with a gradual reduction in intensity for the last few cycles. Thus the sounds appeared to rise out of background and disappear back into it. The endings of the sounds also were further obscured by reflections and reverberations. Measurement of the duration of a sound depended

on its relative intensity over ambient. Individual minke whale sounds lasted from 0.2 to 0.3 seconds.

No repetitive pattern was evident in sequential sounds either from one individual or from both. Of nine sounds presumed to be from one whale and recorded on one continuous tape, the intervals between sounds (in seconds) were approximately 19, 8, 13, 97, 35, 10, 89, and 12.

The sounds were not all identical, but had a basic similarity in duration, frequency sweep, and intensity. Differences could not be attributed easily to characteristics of individual whales, though certainly that possibility exists.

DISCUSSION

Intense low-frequency sounds have been recorded in the presence of other species of *Balaenoptera*. Schevill and Watkins (1962) reported a 75- to 40-Hz sound from *B. physalus* (Linnaeus 1758), and Schevill, Watkins, and Backus (1964) identified a 20-Hz (23–18 Hz) sound also with *B. physalus*. More recently, other low-frequency sounds have been reported from *B. physalus*, 20 Hz to 100 Hz, and *B. edeni* Anderson 1879, with average frequency of 124 Hz, by Thompson and Cummings (1969), and from *B. musculus* (Linnaeus 1758), with most energy below 50 Hz, by Cummings and Thompson (1971). The intensity of most of these low frequency whale sounds has been estimated to be 60 dB or more re 1 dyne/cm² at 1 m.

Other sorts of sounds also have been reported from *Balaenoptera*. These include pulses at about 25 kHz from *B. musculus* by Beamish and Mitchell (1971), and chirps and whistles at 1500 to 2000 Hz from *B. physalus* by Perkins (1966). Our gear is capable of receiving such sounds, and with it we have listened to a few hundred *Balaenoptera* over many years, and yet we have recorded only lower-frequency sounds from them.

The minke whale sound is similar in most respects to both the 75- to 40-Hz and the 23- to 18-Hz sounds in our recordings of the larger fin whale, *B. physalus*. The one from *B. acutorostrata* and these two from *B. physalus* (1) are relatively intense, (2) are composed of low frequencies, (3) have a downward sweep in frequency, (4) are nonharmonic, nearly sine-wave, (5) are made up of about the same number of cycles duration at the same relative intensity (about 20 cycles at 40 dB above background), and (6) begin with gradually increasing intensity and end with

dropping intensity. The differences in these sounds are mainly those related to frequency. This would seem to indicate a common method of sound production and similar acoustic structures.

Neither the 75- to 40-Hz finback whale sound nor the 120- to 60-Hz sound of the minke whale has shown the regular, repeated patterns often found in the 23- to 18-Hz finback sounds. (These latter are often called simply 20-Hz pulses because they usually have been examined through band-pass filters centered at 20 Hz.)

The conspicuous silence of *Leptonychotes* while the minke whales were about is puzzling. Did they confuse them with killer whales? One might expect the seals to be good enough cetologists to differentiate between killers and minkes. Killer whales, *Orcinus orca* (Linnaeus 1758), are frequent visitors to the ice edge, and the seals, one would suppose, might have developed some respect for them. There was no obvious panic, however, in the demeanor of a band of emperor penguins congregated near the holes. Nevertheless, they stayed away from the water during the whales' visit.

We presume that the minke whales sought out the holes in the thin ice because the shift in the heavy pack had closed other breathing spaces in the vicinity. Our failure to hear the whale sounds again after the minkes' disappearance suggests a swim under the pack to some other distant open water.

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Figure 1. A minke whale pushes its head through broken ice for a breath of air. The hole was about one-half this size before the whale began using it. Initially, they had to push their heads nearly vertically through the ice hole, but as more and more ice was broken by their efforts, the hole became large enough for nearly normal (horizontal) attitudes during breathing. Ross Island in background. Watkins phot.

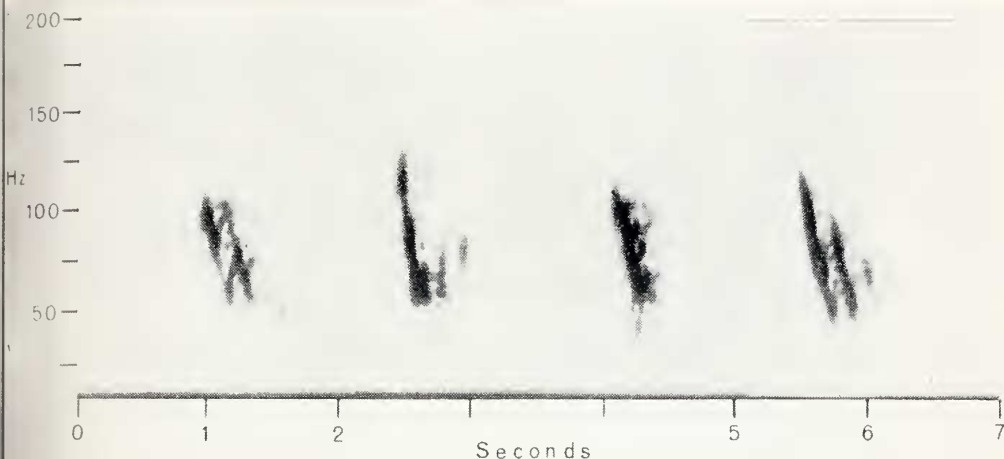


Figure 2. Four minke whale sounds are analyzed without intervening intervals—up to two minutes elapsed between sounds. The high level of the sounds relative to background permits analysis without obvious interference from ambient sound. The second and third traces accompanying the minke whale sounds are from reflections off the bottom or off ice walls. The slightly beaded appearance of the sound traces probably is a result of multiple-path sound transmission with constructive and destructive reinforcement of the sound as the wave length (from about 11.5 to 25 m) varies with the sweep in frequency. The effective analyzing filter bandwidth was 11 Hz.

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